A NEW EYE COLOR MUTATION IN DROSOPHILA AND ITS MODE OF INHERITANCE.

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A cross between a long-winged, vermilion-eyed female and a miniature-winged, red-eyed male yielded in the first generation red-eyed females and vermilion-eyed males, both long-winged. There appeared, however, in addition 15 long-winged males with a new eye color. This color is of the same general tone as the vermilion pink eye but is paler and somewhat creamier. A lighter area may also be seen encircling the darker area of the center.

The origin of this new eye color was accounted for as follows: Since vermilion is sex-linked, all the sons must be vermilion whatever else they may be. Only males of the new eye color appeared, wherefore it was inferred that the something else added was also sex-linked. There were too many of them (15) to be explained each as a separate mutation, and it seems clear that the mutation itself occurred back in the stock from which the mothers were taken. If one or more of these P_1 vermilion females were heterozygous for the new sex-linked factor we should expect in F_1 several of the double recessive males of the composition cherry vermilion. (It was decided to call the new eye color cherry vermilion.)

If then this eye color represents a double recessive cherry vermilion, when mated to red eye (the normal eye color) there should result in F_1 only red-eyed offspring. Then in F_2, if both of these factors are sex-linked, there should appear four classes of males, viz., the double recessive cherry vermilion, and cherry and vermilion as the result of splitting cherry vermilion into its components, and also red eye color which is the double dominant. All the females should be red. That these results were actually realized can be seen below.

red ♀ × cherry verm. ♂ = { red ♀ 762 / red ♂ 758 } { red ♀ ..... 345 / red ♂ ..... 114 / cherry ♂ ..... 41 / verm. ♂ ..... 54 / cherry verm. ♂ .... 120 }

The four classes of males taken together number 329, which approximates to the 345 red females. The results may be accounted for in the following way, using the new system of symbols proposed by Morgan (1912).

P_1 red..... ♀ XCV — XCV
cherry verm... ♂ Xcv — ——

F_1 FEMALE. F_1 MALE.
{XCV / Xcv} red ♀ {XCV / ——} red ♂

Gametes of F_1 ♀ XcV — XCV — Xcv — XCv
Gametes of F_1 ♂ XCV — ——

F_2 FEMALES.		F_2 MALES.	
XcV / XCV	red ♀	XcV / ——	cherry ♂
XCV / XCV	red ♀	XCV / ——	red ♂
Xcv / XCV	red ♀	Xcv / ——	cherry verm. ♂
XCv / XCV	red ♀	XCv / ——	verm. ♂

It will be noted that the red-eyed females belong to four classes pure red, reds heterozygous for vermilion, reds heterozygous for cherry, and reds heterozygous for vermilion and cherry. The red and cherry vermilion male classes are each about twice as numerous as the cherry and the vermilion classes respectively. This disturbance in the ratio is due to linkage between cherry and vermilion.

CHERRY VERMILION BY VERMILION.

When vermilion-eyed females were mated to cherry vermilion-eyed males all the offspring, 483 in number, were vermilion. These when inbred produced vermilion females, vermilion males and cherry vermilion males.

verm. ♀ by cherry verm. ♂ = {verm. ♀ 252 / verm. ♂ 231} > {verm. ♀ .....374 / verm. ♂ .....158 / cherry verm. ♂ ...158}

The results bear out the view that the new eye color represented the double recessive; vermilion plus some other sex-linked factor, viz., cherry, as the analysis shows:

P_1 verm. ♀ .....XCv — XCv
cherry verm. ♂ .....Xcv — ——

F_1 Female.	F_1 Male.
XCv / Xcv	XCv / ——
verm. ♀	verm. ♂

F_2 Females.		F_2 Males.	
XCv / XCv	vermilion ♀	XCv / ——	vermilion ♂
Xcv / XCv	vermilion ♀	Xcv / ——	cherry verm. ♂

The expectation is as many vermilion as cherry vermilion males and the count shows this is exactly realized.

Cherry Vermilion by Pink.

When pink-eyed females were mated to cherry vermilion males all the offspring, 381 in number, were red. These, when inbred, should produce red, cherry, vermilion, pink, cherry vermilion, cherry pink, vermilion pink and cherry vermilion pink males. Because of difficulty of separation the male classes vermilion pink, cherry pink, cherry vermilion, and cherry vermilion pink were put into one general class. The females were of two classes only, viz., red and pink. The following analysis gives the expectation:

pink ♀ × cherry verm. ♂ = { red ♀ / red ♂ } >

red ♀	330
pink ♀	79
red ♂	87
cherry ♂	40
verm. ♂	48
pink ♂	29
cherry verm. ♂	126
cherry pink ♂	
verm. pink ♂	
cherry verm. pink ♂	

The eight classes of males taken together number 430 as compared with 409 red and pink females. The results may be accounted for in the following way:

P_1 pink ♀ ..... XCVp — XCVp
cherry verm. ♂ ..... XcvP — ——P

F_1 Female.	F_1 Male.
XCVp / XcvP	XCVp / ——P
red ♀	red ♂

Gametes of F_1 ♀.

XcVp — XCVp — XcvP — XCvP
XcVP — XCVP — Xcvp — XCvp

Gametes of F_1 ♂.

XCVP — XCVp — ——P — ——p

F_2 Females.	F_2 Males.
XcVp - XCVP....red ♀	XcVp - ——P....cherry ♂
XcVP - XCVP....red ♀	XcVP - ——P....cherry ♂
XCVp - XCVP....red ♀	XCVp - ——P....red ♂
XCVP - XCVP....red ♀	XCVP - ——P....red ♂
XcvP - XCVP....red ♀	XcvP - ——P....cherry verm. ♂
Xcvp - XCVP....red ♀	Xcvp - ——P....cherry verm. ♂
XCvP - XCVP....red ♀	XCvP - ——P....verm. ♂
XCvp - XCVP....red ♀	XCvp - ——P....verm. ♂
XcVp - XCVp....pink ♀	XcVp - ——p....cherry pink ♂
XcVP - XCVp....red ♀	XcVP - ——p....cherry ♂
XCVp - XCVp....pink ♀	XCVp - ——p....pink ♂
XCVP - XCVp....red ♀	XCVP - ——p....red ♂
XcvP - XCVp....red ♀	XcvP - ——p...cherry verm. ♂
Xcvp - XCVp....pink ♀	Xcvp - ——p...cherry verm. pink ♂
XCvP - XCVp....red ♀	XCvP - ——p....verm. ♂
XCvp - XCVp....pink ♀	XCvp - ——p....verm. pink ♂

It will be noted that the expectation is three red females to one pink female, but the actual count, because of disturbances due to viability, is four red females to one pink female. The male count does not agree with simple expectation in two instances. Both the vermilion and cherry classes which should be as numerous as the red (and the cherry vermilion respectively) are much less numerous than expectation. This, however, is due to coupling between cherry and vermilion.

Cherry Vermilion by Vermilion Pink.

When vermilion pink females were mated to cherry vermilion males all the offspring, 635 in number, were vermilion. These when inbred produced vermilion females, vermilion pink females, vermilion males, cherry vermilion males, vermilion pink males and cherry vermilion pink males. Because of difficulty of separation I have included the last two classes in a general class.

verm. pink ♀ × cherry verm. ♂ = { verm. ♀, verm. ♂ } >

verm. ♀	509
verm. pink ♀	208
verm. ♂	223
verm. pink ♂	89
cherry verm. ♂, verm. pink cherry. ♂	319

The four classes of males taken together number 631; the vermilion and the vermilion pink (orange) females number 717.

P_1	verm. pink ♀	XCvp	—	XCvp
	cherry verm. ♂	XcvP	—	——P

	F1 Female		F1 Male.	
	XCvp XcvP verm. ♀		XCvp ——P verm. ♂	
Gametes of F1 ♀	XCvp	XcvP	XCvP	Xcvp
Gametes of F1 ♂	XCvp	XCvP	——P	——p
	F2 Females.		F2 Males.	
	XCvp XCvp	verm. pink ♀	XCvp ——P	vermilion ♂
	XcvP XCvp	vermilion ♀	XcvP ——P	cherry verm. ♂
	XCvP XCvp	vermilion ♀	XCvP ——P	vermilion ♂
	Xcvp XCvp	verm. pink ♀	Xcvp ——P	cherry verm. ♂
	XCvp XCvP	vermilion ♀	XCvp ——p	verm. pink ♂
	XcvP XCvP	vermillon ♀	XcvP ——p	cherry verm. ♂
	XCvP XCvP	vermilion ♀	XCvP ——p	vermilion ♂
	Xcvp XCvP	vermilion ♀	Xcvp ——p	cherry verm. pink ♂

The count shows that the vermilion pink females in spite of their low viability ran above expectation. The males fall into four classes, two of which can be easily separated out. The cherry vermilion pinks, however, are difficult to distinguish from the cherry vermilions and are therefore included in that class. Together they should be four times as numerous as the vermilion pink class, and the vermilion class ought to be three times as nu merous as the latter, which is actually the case.

Cherry Vermilion by White.

When white-eyed females were mated to cherry vermilion-eyed males all the male offspring the first generation, 363 in number, were white. The females, 392 in number, were cherry. These when inbred produced in the second generation, white females, cherry females, white males, cherry males and cherry vermilion males.

white ♀ by cherry verm. ♂ = { white ♂ 363 / cherry ♀ 392 } { white..... ♀ ....347 / cherry..... ♀ ....334 / white..... ♂ ....321 / cherry..... ♂ ....112 / cherry verm..... ♂ 222 }

P$_1$ white..... ♀ XcVw — XcVw
cherry verm..... ♂ XcvW — ——

F$_1$ FEMALE. F$_1$ MALE.
XcVw XcVw
XcvW ——
cherry ♀ white ♂

GAMETES OF F$_1$ ♀ XcVw — XcvW — XcVW — Xcvw
GAMETES OF F$_1$ ♂ XcVw — ——

F$_2$ FEMALES. F$_2$ MALES.

XcVw / XcVw	white ♀	XcVw / ——	white ♂
XcvW / XcVw	cherry ♀	XcvW / ——	cherry verm. ♂
XcVW / XcVw	cherry ♀	XcVW / ——	cherry ♂
Xcvw / XcVw	white ♀	Xcvw / ——	white ♂

The expectation is an equal number of white females and cherry females. The actual count was 347 white females and 334 cherry females. Of the three classes of males the expectation is as many white males as cherry and cherry vermilion put together which is the case as the figures show: 321 white males and 334 cherry and cherry vermilion males. The cherry and cherry vermilion males should be in equal numbers. But this is not the case in the actual count as the cherry vermilion males are twice as numerous as the cherry males: 222 of the former to 112 of the latter. This effect is due to linkage.

CHERRY VERMILION BY EOSIN.

When eosin-eyed females were mated to cherry vermilion-eyed males all the male offspring in the first generation were eosin and the females were cherry. These when inbred produced in the second generation, eosin females, cherry females, eosin males, cherry males, cherry vermilion males, and eosin vermilion males.

Because of difficulty of separation, I have placed the cherry and the eosin females in one general class. For the same reason I have placed the eosin and the cherry vermilion males in one general class.

eosin ♀ by cherry verm. ♂ = { eosin ♂ 119 / cherry ♀ 154 } { eosin ♀..... / cherry ♀..... } 110; { eosin ♂..... / cherry ♂.....20 / cherry verm. ♂..... / eosin verm. ♂.....18 } 76

The results may be accounted for in the following way:

P eosin..... ♀ XcVe — XcVe
cherry verm..... ♂ XcvE — ——

F1 FEMALE. F1 MALE.
XcVe XcVe
XcvE ——
cherry ♀ eosin ♂

GAMETES OF F1 ♀ XcVe — XcvE — Xcve — XcVE
GAMETES OF F1 ♂ XcVe — ——

F2 FEMALES.		F2 MALES.	
XcVe / XcVe	eosin ♀	XcVe / ——	eosin ♂
XcvE / XcVe	cherry ♀	XcvE / ——	cherry verm. ♂
Xcve / XcVe	eosin ♀	Xcve / ——	eosin verm. ♂
XcVE / XcVe	cherry ♀	XcVE / ——	cherry ♂

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